

# Disassembly and Assembly

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## **1103 and 1104 Industrial Engines**

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DC (Engine)  
DD (Engine)  
DJ (Engine)  
DK (Engine)  
RE (Engine)  
RG (Engine)  
RJ (Engine)  
RR (Engine)  
RS (Engine)  
DF (Engine)  
DG (Engine)

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## Installation Procedure

i02216956

### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

**Note:** The installation procedure is identical for the four cylinder and the three cylinder engines. The illustration shows the four cylinder engine.

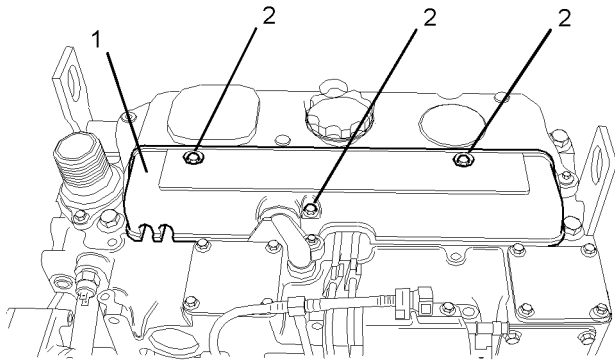


Illustration 15

g01011111

Typical example

1. Thoroughly clean all of the inner surfaces of the cover (1) for the fuel injectors.
2. Install the cover (1).
3. Install the setscrews (2) for the cover (1). Tighten the setscrews (2) to a torque of 9 N·m (7 lb ft).

## Fuel Injection Pump - Remove (Delphi DP210)

### Removal Procedure

#### Start By:

- a. Remove the fuel injection lines. Refer to this Disassembly and Assembly Manual, "Fuel Injection Lines - Remove".
- b. Remove the crankshaft pulley. Refer to this Disassembly and Assembly Manual, "Crankshaft Pulley - Remove and Install".
- c. Remove the front cover. Refer to this Disassembly and Assembly Manual, "Front Cover - Remove and Install".

**Note:** The removal procedure is identical for the four cylinder and the three cylinder engines. The illustrations show the four cylinder engine.

### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the No. 1 cylinder is at top dead center on the compression stroke. Refer to the Testing and Adjusting Manual, "Finding Top Center Position for No. 1 Piston".

1. Ensure that the No. 1 cylinder is at top dead center on the compression stroke. Refer to the Testing and Adjusting Manual, "Fuel Injection Timing - Check".

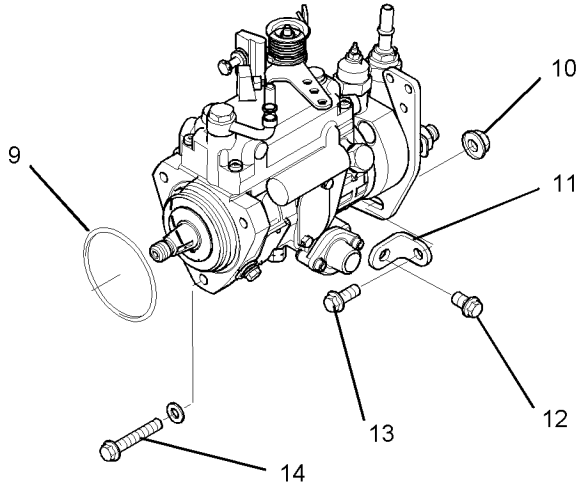


Illustration 37

g01062396

**Note:** Do not lubricate the new O-ring (9). The O-ring should be installed dry.

2. Install the new O-ring (9) onto the fuel injection pump. Position the fuel injection pump onto the front housing. Install the setscrews (14). Tighten the setscrews (14) to a torque of 25 N·m (18 lb ft).
3. Install the setscrew (12) and the bracket (11) onto the cylinder block if the bracket was previously removed. Ensure that the bracket (11) supports the fuel injection pump without applying any other external force on the fuel injection pump. Tighten the setscrew (12) to a torque of 44 N·m (32 lb ft).
4. Install the bolt (13) and the nut (10).

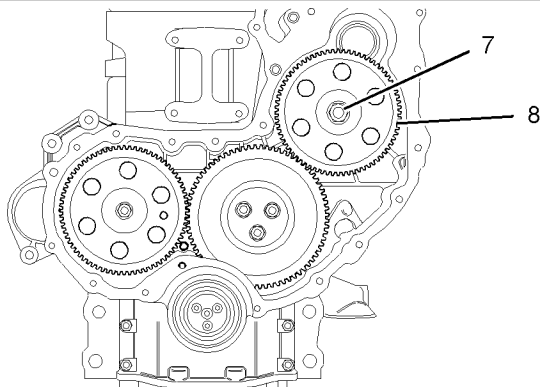


Illustration 38

g01062397

Typical example

**Note:** Ensure that the mating surfaces of the fuel injection pump gear and the shaft of the fuel injection pump are clean. Lubricate the threads of the shaft for the fuel injection pump. The nut (7) must turn freely until contact is made with the fuel injection pump gear.

5. Position the fuel injection pump gear (8) onto the shaft of the fuel injection pump. Install the washer and the nut (7). Rotate the fuel injection pump gear (8) in a counterclockwise direction in order to remove the backlash. Tighten the nut (7) to a torque of 24 N·m (17 lb ft).

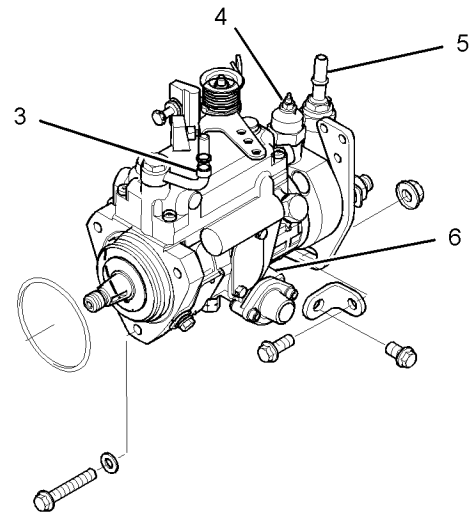


Illustration 39

g01062395

6. Connect the harness assembly to the timing advance solenoid (6).
7. Connect the harness assembly (4).
8. Remove all of the dust caps from the connectors on the fuel injection pump. Remove all of the plugs from the fuel hose assemblies and from the tube assemblies.
9. Connect the fuel line (5) to the fuel injection pump. Connect the fuel return line (3) to the fuel injection pump.

**Note:** The top flange of the oil drain tube assembly (9) is secured to the turbocharger (1) with 6 mm setscrews (8). The bottom flange of the oil drain tube assembly (9) is secured to the cylinder block with 8 mm setscrews (11).

8. Position a new joint (10) and the oil drain tube assembly (9) onto the bottom of the turbocharger (1). Install the 6 mm setscrews (8). Tighten the 6 mm setscrews (8) to a torque of 9 N·m (80 lb in).
9. Position a new joint and the oil drain tube assembly (9) onto the cylinder block. Tighten the 8 mm setscrews (11) to a torque of 22 N·m (16 lb ft).
10. Position the new washers (7) and the oil supply tube assembly (6) onto the turbocharger (1). Install the banjo bolt (5). Tighten the banjo bolt (5) to a torque of 22 N·m (16 lb ft).

**Note:** Ensure that the oil supply tube assembly (6) does not come into contact with any other component when the assembly is installed onto the engine.

11. Install the new washers and the oil supply tube assembly (6) to the cylinder block. Tighten the banjo bolt to a torque of 22 N·m (16 lb ft).
12. If the studs (12) were previously removed, install the studs into the turbocharger housing.

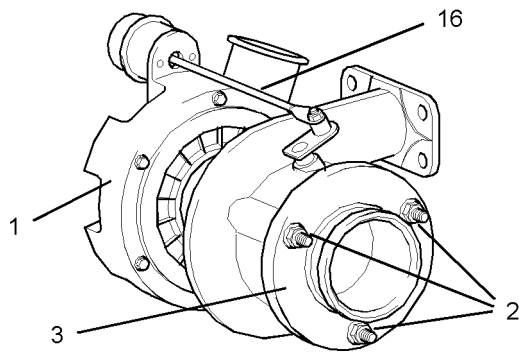


Illustration 60  
Typical example g01038406

13. Position the exhaust adapter (3) onto the studs (12). Install the nuts (2). Do not tighten the nuts (2) at this time.

**Note:** Exhaust elbows are only an option for the four cylinder engines.

14. If equipped, install the exhaust elbow onto the exhaust adapter (3). Refer to this Disassembly and Assembly Manual, "Exhaust Elbow - Remove and Install".

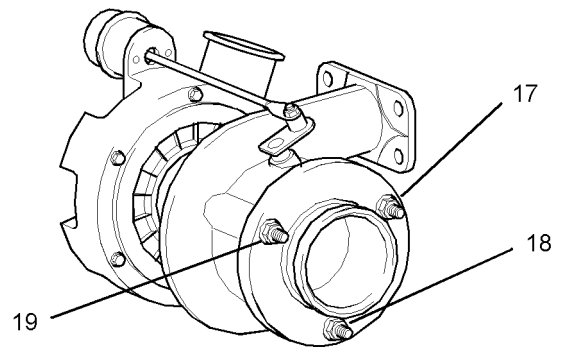


Illustration 61 g01038456

15. Tighten the three nuts finger tight in the sequence (17), (18), and (19). Tighten the nuts (17), (18), and (19) in the same sequence to a torque of 25 N·m (18 lb ft).
16. Ensure that there is no restriction in the inlet hose. Position the air inlet hose on the turbocharger compressor housing. Install the hose clamps. Tighten the hose clamps to a torque of 5 N·m (44 lb in).

**Note:** The air inlet hose has a reflective heat shield that partially covers the hose. The reflective heat shield must be installed toward the engine. The reflective heat shield must be kept clean and free from dust, oil or paint.

**Note:** Apply a solution of water and 5% soap to the inlet of the turbocharger in order to install a new air inlet hose. Do not use oil or grease in order to install the air inlet hose.

17. Position the exhaust pipe onto the exhaust elbow or onto the turbocharger outlet (3). Refer to the OEM information for the correct procedure in order to install the exhaust pipe.

i01946913

## Exhaust Manifold - Remove and Install

### Removal Procedure for the Three Cylinder Engine

#### Start By:

- a. Remove the turbocharger, if equipped. Refer to this Disassembly and Assembly Manual, "Turbocharger - Remove".

i01947654

# Inlet and Exhaust Valve Seat Inserts - Remove and Install

## Removal Procedure

### Start By:

- a. Remove the inlet valves and the exhaust valves. Refer to this Disassembly and Assembly Manual, "Inlet and Exhaust Valves - Remove and Install".

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

**Note:** When new valve seat inserts are installed, new valves and new valve guides must be installed.

1. Remove the appropriate valve guides. Install partially finished valve guides. Refer to this Disassembly and Assembly Manual, "Inlet and Exhaust Valve Guides - Remove and Install".

**Note:** The inserts for the inlet valves are a larger diameter than the exhaust valve inserts.

2. Use the partially finished bore of the valve guide as a pilot bore in order to remove the valve insert by machining. Also use the partially finished bore of the valve guide as a pilot bore in order to machine a recess for a new valve seat. Refer to the Specifications Manual, "Cylinder Head Valves" for the required dimensions of the recess for the valve seat. Remove all debris from the cylinder head ports and passages.

3. Repeat the Step 2 for all of the appropriate valve seats.

## Installation Procedure

Table 7

Required Tools		
Part Number	Part Description	Qty
27610030	Valve Guide/Valve Seat Reamer/Cutter	1

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

**Note:** If the cylinder head has been previously ground then the bottom face of valve seat must be ground in order to ensure that the valve seat will be installed correctly into the cylinder head. A 30 degree chamfer must be machined to the outer edge of the valve seat after the back face of the valve insert has been ground to the correct dimensions. The 30 degree chamfer must be within the tolerance of 0.91 mm (0.036 inch) to 1.3 mm (0.051 inch). Also, the chamfer must be inclined to the vertical face of the valve insert.

**Note:** Do not use a hammer in order to install the valve insert into the machined recess in the cylinder head.

**Note:** Do not apply any lubricant before the new valve seat insert is installed into the cylinder head.

1. Use a suitable tool to install the valve seat insert into the machined recess in the cylinder head.

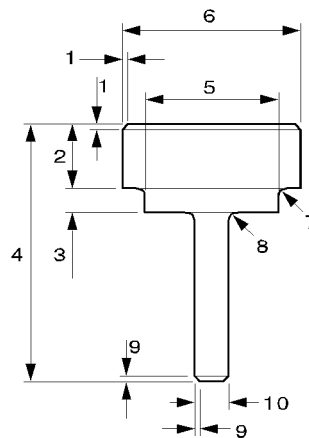


Illustration 77

g01016768

2. If necessary, a suitable tool can be manufactured. Refer to the illustration 77. Also refer to the table 8 and refer to the table 9 for suitable dimensions.

i01958108

## Installation Procedure

### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean the spring (3) and the plunger (4) of the engine oil relief valve. Check the spring (3) and the plunger (4) for wear or for other damage. The plunger (4) must slide easily within the bore of the oil relief valve within the engine oil pump (1). Lubricate the spring (3) and the plunger (4) with clean engine oil.

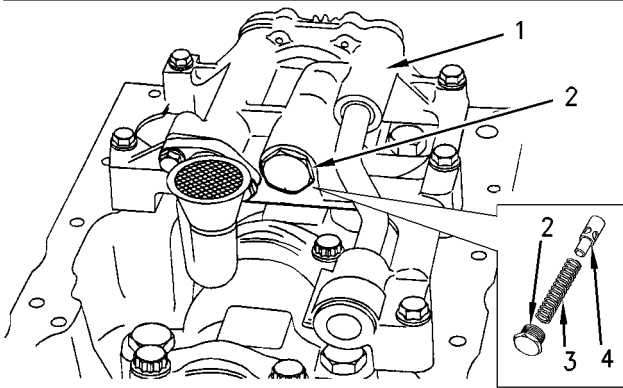


Illustration 96

g00959674

### WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

2. Install the plunger (4) and the spring (3) in the engine oil pump (1).
3. Install the plug (2). Tighten the plug (2) to a torque of 22 N·m (16 lb ft).

### End By:

- a. Install the engine oil pan. Refer to this Disassembly and Assembly Manual, "Engine Oil Pan - Remove and Install".

## Engine Oil Relief Valve - Remove and Install (Balancer Unit for the 1104 engines only)

### Removal Procedure

#### Start By:

- a. Remove the engine oil pan. Refer to this Disassembly and Assembly Manual, "Engine Oil Pan - Remove and Install".

### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

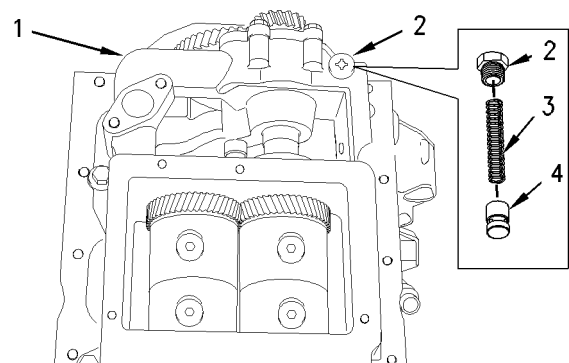


Illustration 97

g00979780

### WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

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i02259836

## Flywheel - Remove

### Removal Procedure

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

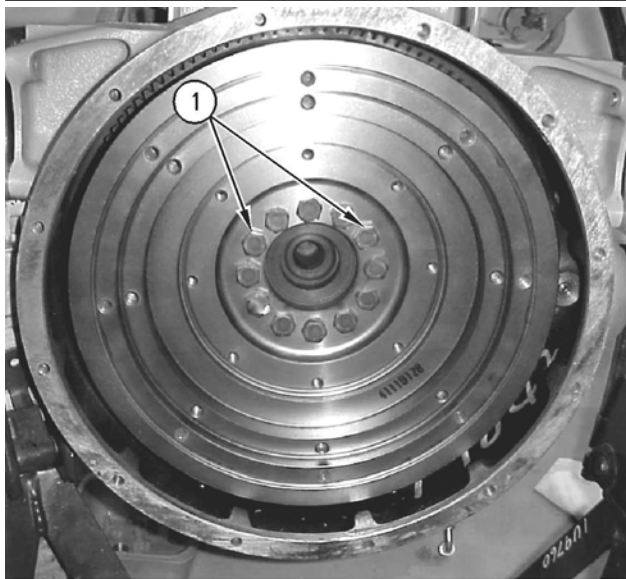


Illustration 120

g00905926

1. Remove the two setscrews (1).

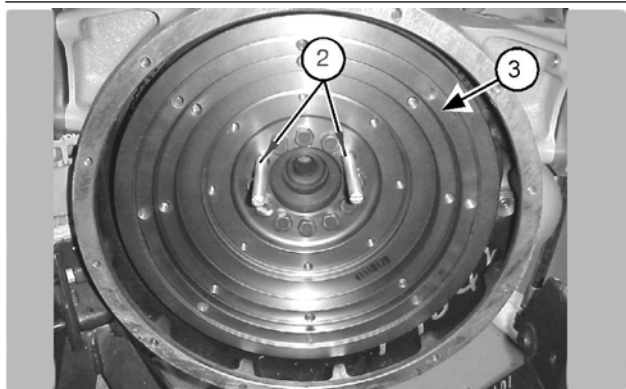


Illustration 121

g01020091

Typical example

2. Install two suitable studs (2) as guides.

**Note:** The flywheel (3) is heavy. Use suitable lifting equipment to support the flywheel (3) before the remainder of the setscrews (1) are removed.

3. Remove the remaining setscrews (1) that secure flywheel (3) to the crankshaft and then remove the flywheel.

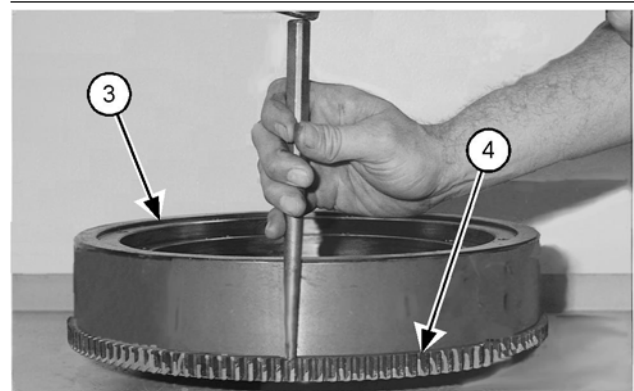


Illustration 122

g01020099

4. Check the condition of the ring gear (4). Remove the ring gear (4) if the ring gear is worn or damaged.

**Note:** Identify the orientation of the ring gear on the flywheel and the position of the chamfer on the teeth for the correct positioning when the new ring gear is installed.

5. Place the flywheel (3) and the ring gear (4) on a suitable support. Use a hammer and a chisel in order to remove the ring gear (4) from the flywheel (3).

i02231069

## Flywheel - Install

### Installation Procedure

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



**Always wear protective gloves when handling parts that have been heated.**

1. Thoroughly clean the flywheel housing. Inspect the crankshaft rear seal for leaks. If there are any oil leaks refer to this Disassembly and Assembly Manual, "Crankshaft Rear Seal - Remove".

- Align the pulley with the "T" mark (8) at the top and in line with the center line of the engine and then install the pulley on the crankshaft. Use a suitable straight edge (7) against the guide pins (9) to aid alignment of the pulley.

**Note:** The pulley can be rotated by a maximum of 4 degrees in a clockwise direction or a counterclockwise direction in order to align the splines in the pulley with the splines on the crankshaft. This is within acceptable limits.

- Remove the straight edge (7) and the two guide pins (9).
- Lubricate the threads and the shoulder of the setscrews (1) with clean engine oil. Position the thrust block (2) and install the setscrews (1). Tighten the setscrews evenly to a final torque of 115 N·m (85 lb ft).
- Tighten each of the setscrews (1) again to the same torque in order to ensure that the setscrews are still at the required torque.

**End By:**

- Install the V-Belts. Refer to this Disassembly and Assembly, "V-Belts - Remove and Install".

i01964539

## Crankshaft Front Seal - Remove

### Removal Procedure

Table 13

Required Tools		
Part Number	Part Description	Qty
27610230	Three legged puller	1

**Start By:**

- Remove the crankshaft pulley. Refer to this Disassembly and Assembly Manual, "Crankshaft Pulley - Remove and Install".
- Thoroughly clean the area around the housing for the crankshaft front seal.

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

**NOTICE**

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

**Note:** Do not remove the crankshaft front seal at this time if the housing (front) will also be removed. It is easier to remove the crankshaft front seal when the housing (front) has been removed from the engine. Refer to this Disassembly and Assembly Manual, "Housing (Front) - Remove".

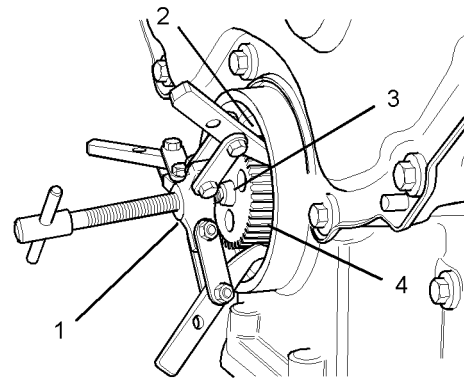


Illustration 148

g01020672

- Install the legs of the puller (1) under the crankshaft front seal (2) and lock the legs into position.
- Install a suitable adapter (3) between the crankshaft (4) and the puller (1).

**NOTICE**

Ensure that the main lip is used in order to remove the crankshaft front seal. Do not damage the edge of the housing for the crankshaft front seal.

- Use the puller (1) in order to remove the crankshaft front seal (2). Discard the crankshaft front seal (2).

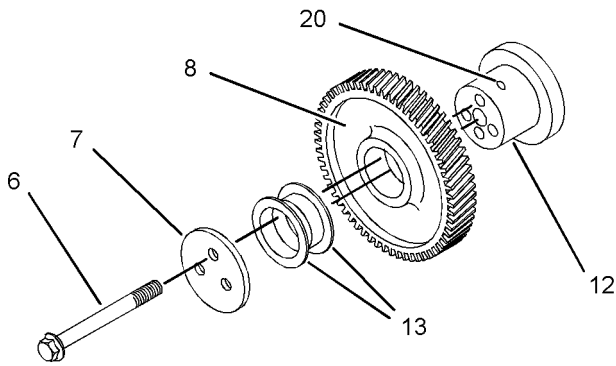


Illustration 172  
Standard idler gear assembly  
g01024432

3. Assemble the assembly (9) of the idler gear and the hub. In order to assemble the standard assembly, press new bushes (13) into the idler gear (8) if the bushes were previously removed. Lubricate the hub (12) with clean engine lubricating oil. Slide the hub (12) into the idler gear (8). Ensure that the oil hole (20) is to the top of the hub (12) and ensure that the marks (19) are to the front of the idler gear (8).

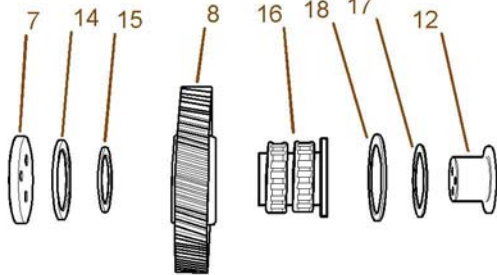


Illustration 173  
Heavy-duty idler gear assembly  
g01023942

**Note:** The new bearing assembly (16) is supplied with a protective sleeve. Do not remove this protective sleeve. The protective sleeve prevents the rollers from falling out of the roller bearings.

4. In order to assemble the heavy-duty idler gear, install the circlip (17) into the back face of the idler gear (8). Place the back face of the idler gear (8) onto a clean, flat surface. Insert the thrust washer (18) through the idler gear (8) and onto the circlip (17). Ensure that the flange face of the bearing assembly (16) is toward the bottom and that the protective sleeve is still in place. Insert the new bearing assembly (16) into the idler gear (8). Push the new bearing assembly (16) into the idler gear (8) until the bearing assembly comes into contact with the thrust washer (18). As the bearing assembly (16) is pushed into the idler gear (8) the protective sleeve will remain on the top face of the idler gear. Discard the protective sleeve. Install the thrust washer (15) and install the circlip (14). Lightly lubricate the hub (12) with clean engine lubricating oil. Press the hub (12) into the idler gear (8).

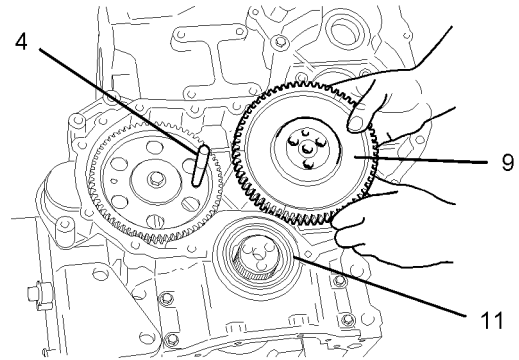


Illustration 174  
g01023843

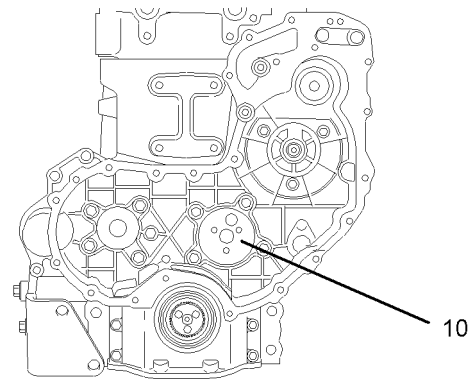


Illustration 175  
g01038902

2. If the valve mechanism cover (1) is equipped with an oil filler cap, check the condition of the O-ring for the oil filler cap. If necessary, replace the O-ring.
3. Install a new joint to the valve mechanism cover (1) and install the valve mechanism cover onto the cylinder head.
4. Check the condition of the fasteners (2). Replace the fasteners (2), if necessary. Install the fasteners (2).

6. If you are working on a four cylinder engine, tighten the fasteners for the valve mechanism cover in the sequence that is shown in Illustration 200. Tighten the fasteners to a torque of 9 N·m (80 lb in).
7. Connect the breather tube (3) to the valve mechanism cover (1). Refer to this Disassembly and Assembly Manual, "Crankcase Breather - Remove and Install".

**End By:**

- a. Install the cover for the fuel injectors. Refer to this Disassembly and Assembly Manual, "Fuel Injector Cover - Remove and Install".
- b. If equipped, ensure that the heat shields are clean and free from dust, oil, and paint. Install the heat shields.

i01947657

## Rocker Shaft and Pushrod - Remove

### Removal Procedure

Table 20

Required Tools		
Part Number	Part Description	Qty
27610227	Rocker Assembly Tool	4

**Start By:**

- a. Remove the valve mechanism cover. Refer to this Disassembly and Assembly Manual, "Valve Mechanism Cover - Remove and Install".

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

**Note:** The removal procedure is identical for the three cylinder and the four cylinder engines. The illustrations show the four cylinder engine.

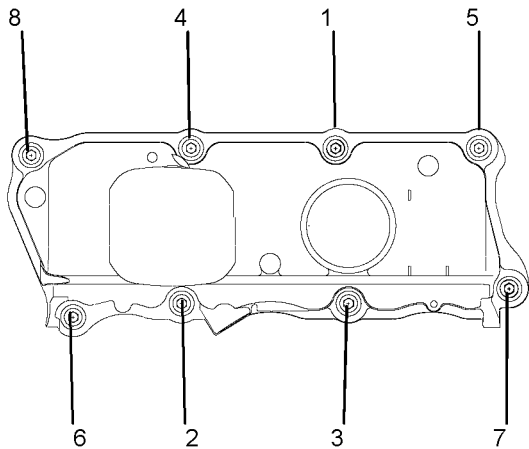


Illustration 199 g01018519  
Sequence for tightening the fasteners for the three cylinder engine

5. If you are working on a four cylinder engine, go to Step 6. If you are working on a three cylinder engine, tighten the fasteners for the valve mechanism cover in the sequence that is shown in Illustration 199. Tighten the fasteners to a torque of 9 N·m (80 lb in). Go to Step 7

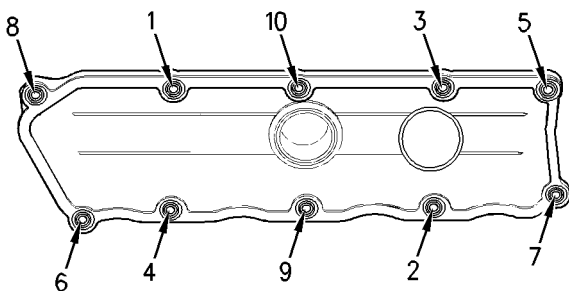


Illustration 200 g00908011  
Sequence for tightening the fasteners for the four cylinder engine

i01977579

## Camshaft - Remove and Install

### Removal Procedure

#### Start By:

- a. Remove the cylinder head if the cylinder head has not previously been removed. Refer to this Disassembly and Assembly Manual, "Cylinder Head - Remove".
- b. Remove the front housing if the front housing has not previously been removed. Refer to this Disassembly and Assembly, "Housing (Front) - Remove".

#### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Turn the engine upside-down so that the cam followers are held in a position away from the camshaft.

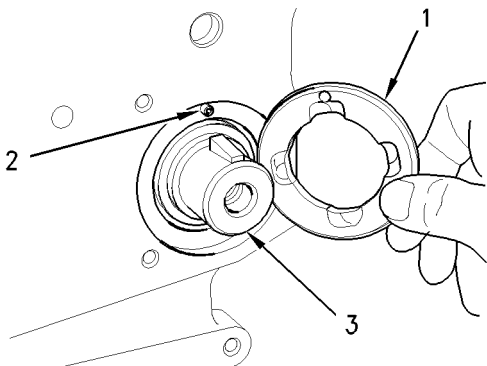


Illustration 224

g00951938

2. Remove the thrust washer (1) if the thrust washer has not previously been removed. Make a note of the location of the hollow dowel (2) for installation purposes.

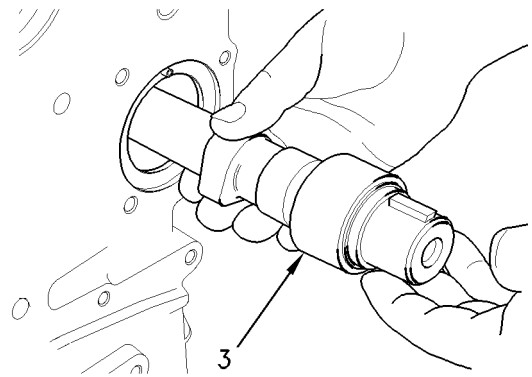


Illustration 225

g00951934

#### NOTICE

Do not damage the lobes or the bearings when the camshaft is removed or installed.

3. Carefully remove the camshaft (3) from the cylinder block.

### Installation Procedure

#### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

**Note:** Ensure that the camshaft (3) is clean. Lubricate the camshaft (3) with clean engine oil prior to installation.

#### NOTICE

Do not damage the lobes or the bearings when the camshaft is removed or installed.

1. Carefully install the camshaft (3) into the cylinder block.
2. Put the thrust washer (1) in position if this is the appropriate time. Make sure that the thrust washer (1) is aligned with the hollow dowel (2).

#### End By:

- a. Install the front housing if this is the appropriate time. Refer to this Disassembly and Assembly Manual, "Housing (Front) - Install".
- b. Install the cylinder head if this is the appropriate time. Refer to this Disassembly and Assembly Manual, "Cylinder Head - Install".

i01939858

# Pistons and Connecting Rods - Assemble

## Assembly Procedure

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

**NOTICE**

Installation of the piston pin bushing must be carried out by personnel with the correct training. Also special machinery is required.

**Note:** A new piston pin bushing is in a shape of a wedge. For further information on installation of the piston pin bushing, refer to your authorized Perkins dealer or your Perkins distributor for assistance.

1. Refer to Testing and Adjusting, "Connecting Rod - Inspect" for the correct height grade for the fractured split connecting rod.



Illustration 246

g01000785

Alignment of the shell

2. The bearing shells for the connecting rod and the connecting rod cap must be aligned by a tool before the bearing shells are installed. Refer to illustration 246. Check the alignment of the bearing shells and remove the alignment tool from the assembly. The bearing shell must be an equal distance from each end. Refer to illustration 247.

**Note:** The alignment tool is supplied with new bearing shells .

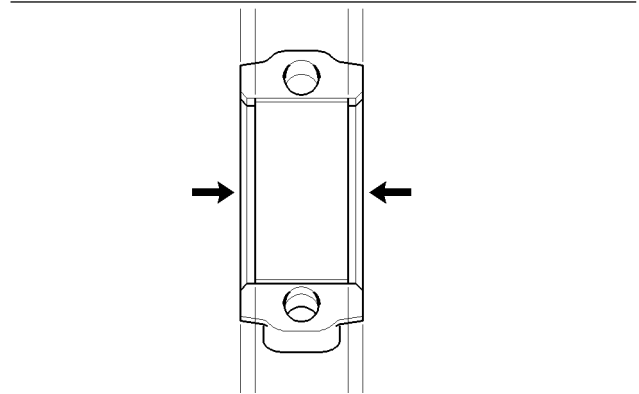


Illustration 247

g01001160

Aligned shell

3. Align the mark (1) on the connecting rod to the boss cutout (2) of the piston. Also check that the arrow (3) that is marked on top of the piston is aligned. Install the piston pin into the piston and through the connecting rod.

**Note:** If the piston pin cannot be installed by hand, use hot water in order to heat the piston to a temperature of  $45^{\circ} \pm 5^{\circ}\text{C}$  ( $113^{\circ} \pm 9^{\circ}\text{F}$ ).

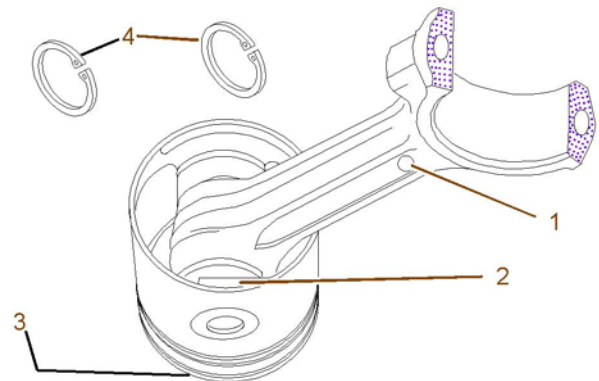


Illustration 248

g01009410

Align the connecting rod to the piston.

4. Use suitable pliers in order to install the circlips (4) that hold the piston pin in position.
5. Use a suitable ring expander in order to install the piston rings on the piston with the following steps.

2. Gently wipe the lower bearing shells (3) and the upper bearing shells (1) in order to ensure that the bearing shells are clean and dry. Inspect the lower bearing shells (3) and the upper bearing shells (1). If necessary, replace the bearing shells that are worn or damaged.

**Note:** Bearing shells must be replaced in pairs. If a pair of bearing shells need to be replaced, consider replacing all of the bearing shells at the same time.

**Note:** The upper bearing shell for the No. 1 crankshaft journal has a lubricating oil slot. The remaining upper bearing shells (1) have an oil hole for lubrication. All new upper bearing shells (1) will have the slot for lubrication.

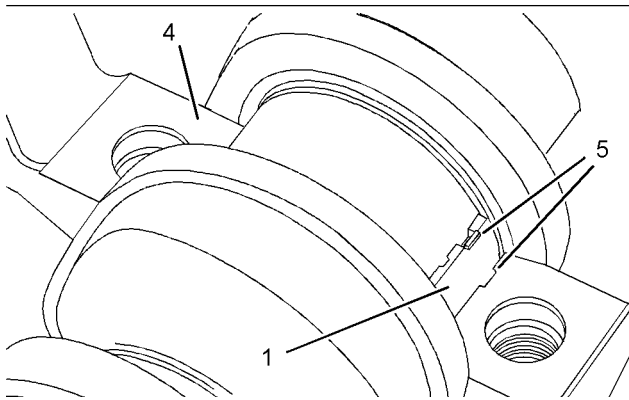


Illustration 273

g01027337

3. Install the upper main bearing shells (1). The bearing tabs (5) for the upper main bearing shells (1) must be located in the correct position in the cylinder block (5). Lubricate the upper main bearing shells (1) with clean engine oil.
4. Ensure that all of the main bearing caps (2) are clean and dry. Ensure that both of the hollow dowels (6) are not damaged and that two hollow dowels are securely in place within each of the main bearing caps (2).

**Note:** This procedure assumes that the engine has been removed from the application and that the engine has been inverted. **If the engine has not been inverted, ensure that the crankshaft is completely supported until the main bearing caps (2) and setscrews are completely installed.**

5. Gently wipe the main journals of the crankshaft in order to ensure that the main journals are clean and dry. Attach suitable lifting straps to the crankshaft.

6. Take care to ensure that you do not scratch any of the finished surfaces on the crankshaft and that you do not damage the upper main bearing shells (1) or dislodge the upper main bearing shells. The crankshaft is heavy. Use suitable lifting equipment to carefully lift the crankshaft into the upper main bearing shells (1).
7. Install the appropriate lower main bearing shells (3) into main bearing caps (2) with the bearing tabs (7) in the correct position. Lubricate the lower main bearing caps (2) with clean engine oil.

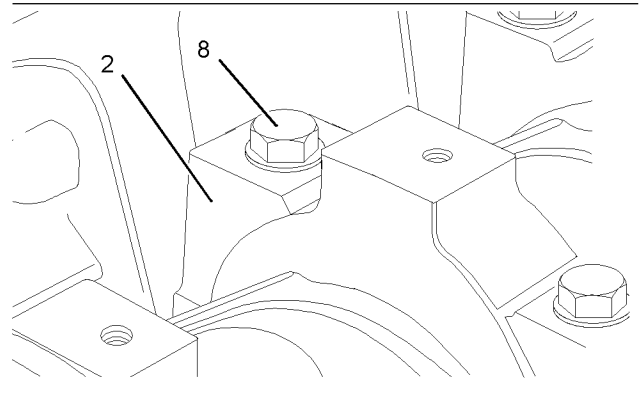


Illustration 274

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**Note:** Do not install the No. 3 main bearing cap of the three cylinder or the center main bearing cap of the four cylinder engine at this time.

8. Use the hollow dowels (6) in order to locate the appropriate main bearing caps (2) and install the main bearing caps into the appropriate housing (4) in the cylinder block. Insert the setscrews (8) finger tight.

**Note:** Thrust washers (9) and (10) are installed onto one main bearing in order to limit crankshaft end play. These thrust washers are installed onto the No. 3 main bearing of the three cylinder and the center main bearing of the four cylinder engine. The installation procedure is identical for the three cylinder and the four cylinder engines. The appropriate illustrations show the four cylinder engine.

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